REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From – To)*
25 Oct 2012	Consultative Letter	April 2012 – September 2012

4. TITLE AND SUBTITLE

Acoustical Assessment of Firing Range, RAF Feltwell, UK

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

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8. PERFORMING ORGANIZATION REPORT NUMBER

AFRL-SA-WP-CL-2012-0063

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Distribution A: Approved for public release; distribution is unlimited. Case Number: 88ABW-2012-5665, 25 Oct 2012

13. SUPPLEMENTARY NOTES

14. ABSTRACT

An acoustical assessment was performed on the firing range at RAF Feltwell in April 2012. It was determined that the definition of impulse noise in AFOSH Standard 48-20 was not met due to acoustical reflections, particularly off the side walls. Therefore, it was recommended that a Risk Assessment Code be assigned to the facility, personnel audiograms be closely scrutinized, and acoustical absorption treatments be added to reduce noise levels and reduce noise decay times.

15. SUBJECT TERMS

Impulse noise, impact noise, time delay, CATM, firing range, hearing, acoustics, noise, firearms

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
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U	U	U	SAR	9	19b. TELEPHONE NUMBER *(include area code)*

DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
WRIGHT-PATTERSON AFB OH

25 October 2012

MEMORANDUM FOR 48 AMDS/SGPB
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SUBJECT: Consultative Letter, AFRL-SA-WP-CL-2012-0063, Acoustical Assessment of Firing Range, RAF Feltwell, UK

1. INTRODUCTION:

a. *Purpose*: On 23-27 April 2012, the Consultative Services Division of the United States Air Force School of Aerospace Medicine (USAFSAM/OEC), at the request of 48 AMDS/SGPB, performed an acoustical assessment of the Combat Arms Training and Maintenance (CATM) firing range facilities at RAF Feltwell, UK.

b. *Survey Personnel:*

(1) Mr. Andrew T. Wells
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c. *Personnel Contacted*:

(1) Maj Tho Tran
(2) Ms. Banasha Sadeghi
(3) TSgt Joshua Boles
(4) TSgt Lawrence Price
(5) SSgt Roy Hudgins
(6) SSgt Rebecca Simpson
(7) SSgt Kenneth Bancroft
(8) SSgt Keith Ulrich
(9) SrA Kevin Hecht

d. *Equipment*:

(1) B&K PULSE Analyzer, Type 3560-B-140, SN 2588445
(2) Larson Davis Microphone Power Supply, Model # 2221, SN 0207

(3) Larson Davis Preamplifier, Model # 902, SN 3824
(4) Larson Davis Microphone, Model # 2530, SN 1483
(5) Quest Calibrator, Model # QC-20, SN QF8050050

2. BACKGROUND:

a. The RAF Feltwell CATM Range is a partially contained range with 21 firing stations divided by a concrete wall into two sections, with 7 stations to the left (see Figure 1) and 14 stations to the right (see Figure 2). The range is used for M4 and M9 training. A reverberant field occurs when firing as energy is reflected among the ceiling, walls, and floor surfaces, causing the noise to linger above background levels. These noise levels diminish slowly compared with free field conditions (i.e., outdoors, or indoors with appropriate acoustical absorption material on the interior surfaces). Down-range of the firing line is a series of steel safety baffles on the ceiling that are designed to deflect stray bullets and prevent the bullets from leaving the range (see Figure 3). These panels are closely spaced and reflect acoustical energy, contributing to the lingering noise levels.

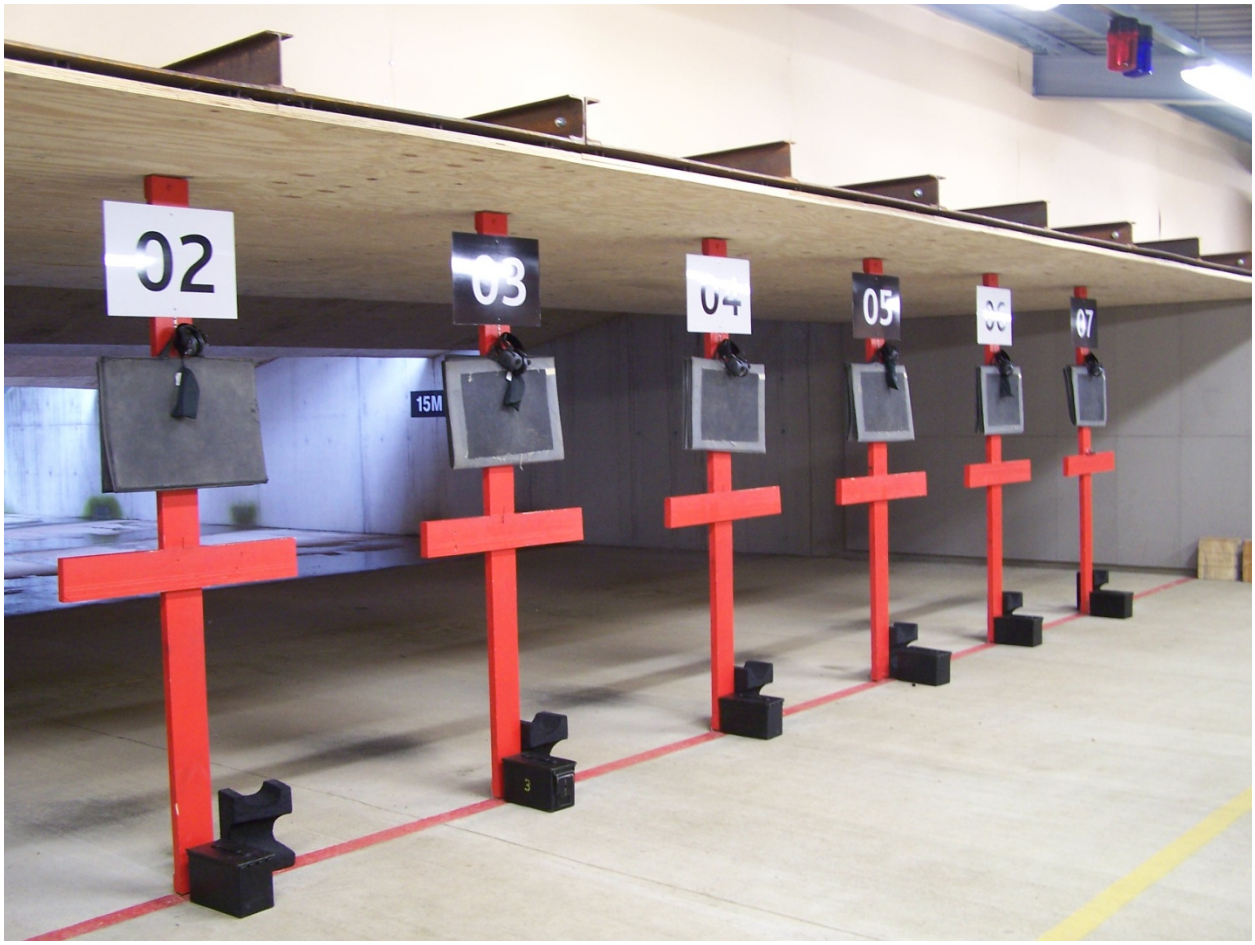

Figure 1. Firing line of RAF Feltwell CATM Range, left side

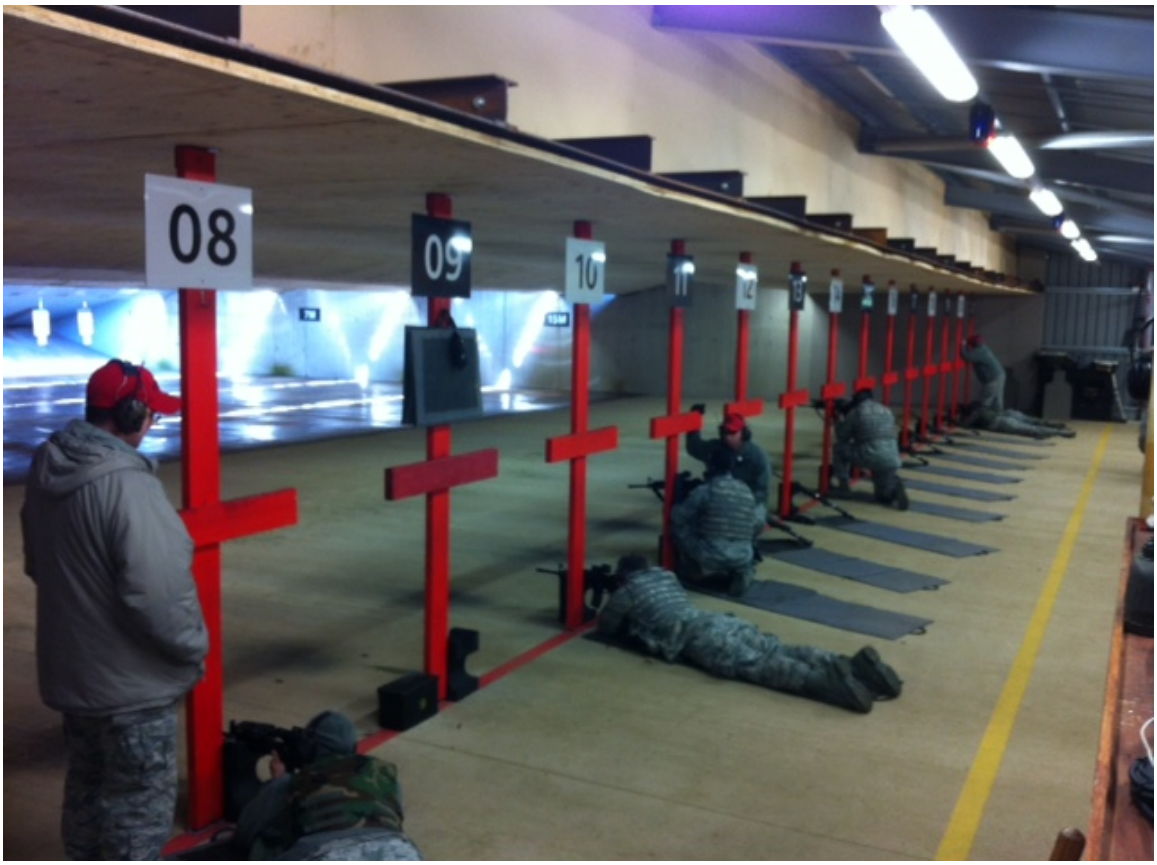

Figure 2. Firing line of RAF Feltwell CATM Range, right side

The back wall, behind the shooters as they face the bullet trap, is perforated sheet metal (see Figure 4). The perforations allow air to flow from a plenum behind the wall toward the bullet trap. Fans on the roof push air into the plenum (see Figure 5). As shown in Figure 4, the wall behind the perforated wall is corrugated sheet metal.

Figure 3. Side wall and overhead containment baffles

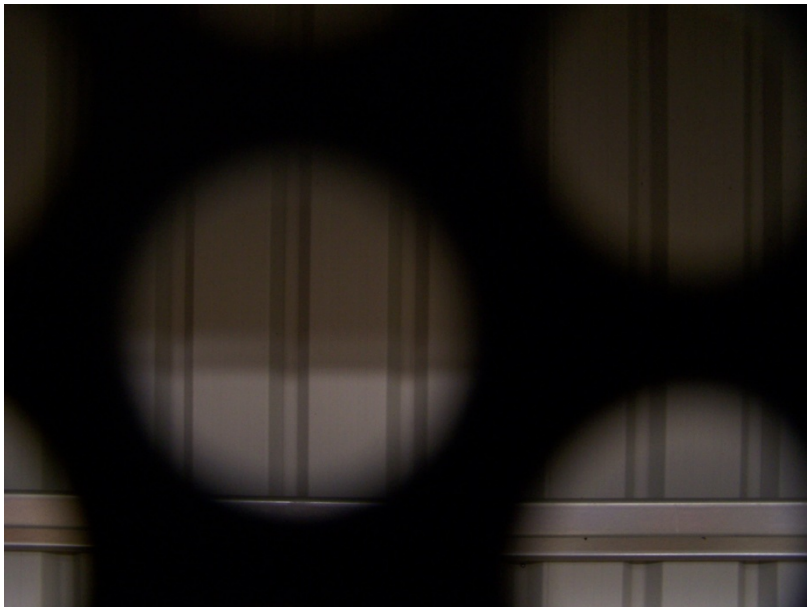

Figure 4. Plenum

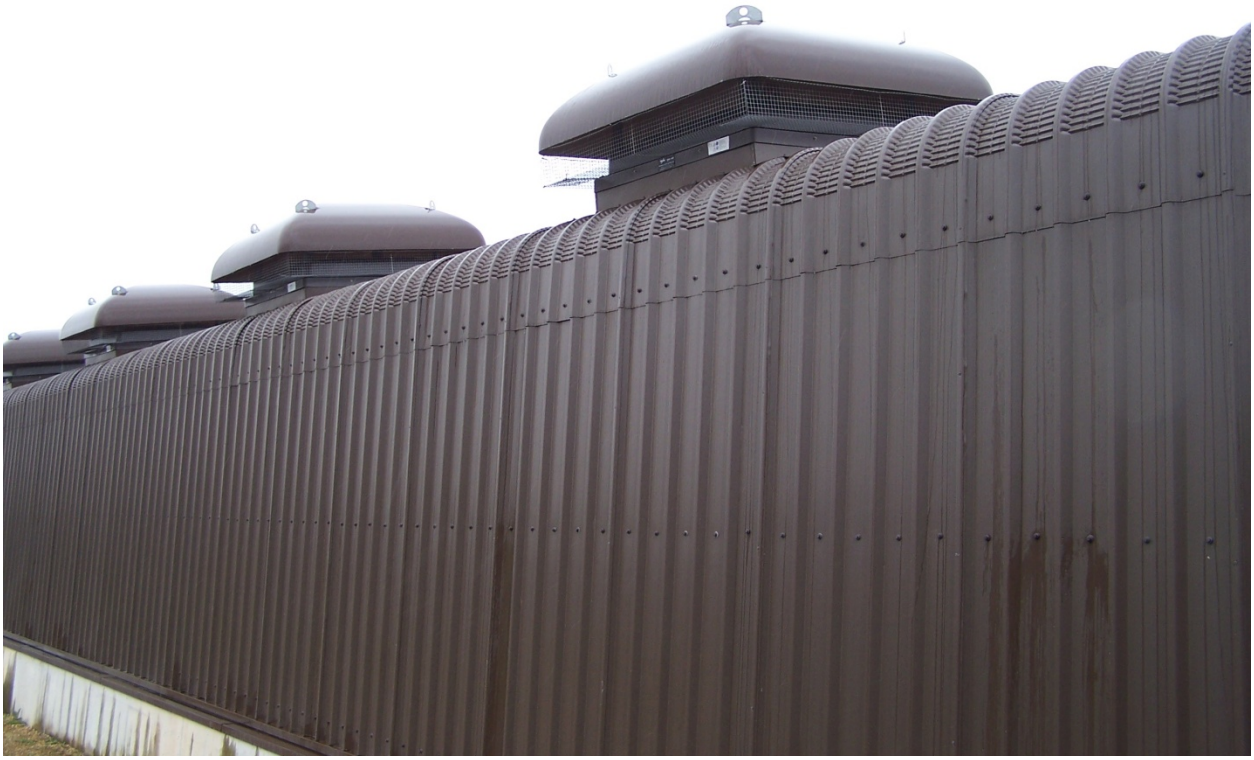

Figure 5. Fans for plenum

b. Firing procedures at the RAF Feltwell CATM Range differ from most AF CATM ranges. Rather than moving the targets closer to or farther from the students to change the distance, the shooters move toward or away from the targets. The targets stay at their designated point near the bullet trap. Therefore, it was necessary to collect data for each firing line.

c. The nonlinear acoustical effects of the gun fire peak noise, double hearing protection, and short-term residual auditory effects from gunfire make it very difficult for students and instructors to communicate. Communication difficulties include understanding instructions and warning signals. To compensate for the multiple noise sources, the volume of the control tower speaker system is fixed at a high level. When hearing protection is not worn (i.e., providing/receiving group instruction), the students are exposed to high (potentially hazardous) levels of noise from the speakers.

3. TEST PROCEDURE:

a. The sound pressure time histories corresponding to individual M4 and M9 shots were measured with ¼-inch microphones placed 5 feet above the yellow line (the safety line behind which students remain when not shooting), or an equal distance behind the forward shooting

locations. Time histories are measured sound pressure over duration of approximately 4 seconds. This duration provided sufficient time to completely describe the decay of the acoustical energy to background levels. These time histories were then used to compute acoustical decay characteristics.

b. The linear sound pressure level decay rates, in decibels per second, were computed by selecting the linear decay phase of each time history and performing a sound level versus time analysis through the decay phase. The slope of this curve is the decay rate.

c. Decay times, in seconds, were computed based on the decay rate by calculating the duration of time required for the sound pressure level to decay from the peak sound pressure level to a fixed level of 80 dB.

4. RESULTS:

a. The decay time, averaged over multiple shots at multiple shooter and microphone locations and two different types of weapons, was 2.2 seconds. See Table 1 for a summary of decay times for respective locations. M4 data at the 7- and 15-meter lines, and M9 data at the 25-meter line, are not reported due to interferences from subsequent shots limiting observable decay. M4 measurements were not performed on the left side of the range. The data collected are sufficient to characterize the range.

TABLE 1: MEAN IMPULSE DECAY TIME (seconds)

M4 Right Side of Range, 25 m	2.5
M9 Left Side of Range, 7 m	2.3
M9 Right Side of Range, 15 m	2.0
M9 Left Side of Range, 7 m	2.1
M9 Right Side of Range, 15 m	2.2

b. In the observed configuration, the noise at this range does not meet the definition of impulse noise as defined in AFOSH Standard 48-20, *Occupational Noise and Hearing Conservation Program*:

> **Impulse or Impact Noise—**a short burst of acoustic energy consisting of either a single burst or a series of bursts. The pressure-time history of a single burst includes a rapid rise to a peak pressure followed by a somewhat lower decay of the pressure envelope to ambient pressure, both occurring within 1 second. A series of impulses may last longer than 1 second.

c. Hearing protection devices (HPD) alone cannot adequately attenuate noise levels to protect students and instructors from hazardous noise exposure. The continuous noise levels in the range can exceed 150 dB at the shooter's ear. With noise levels at 150 dB and assuming double hearing protection—using HPD with a higher noise-reduction rating of 30+3 dB for dual protection (per AFOSH Standard 48-20) and de-rated by 50% (per OSHA)—the at-ear noise level would exceed 134 dBA.

5. CONCLUSIONS:

a. Speech intelligibility is poor due to the strong reverberant sound field of the range. This condition increases safety risks.

b. Based on an average decay time of 2.2 seconds, the noise in the range does not meet the regulatory definition of impulse noise. The continuous noise standard is therefore applicable, so there is no allowed exposure time above 115 dBA.

c. There is currently some acoustical treatment on the side walls near the 25-meter line, but the decay time in this area is greater than at the 7- and 15-meter lines, where there is no such treatment. This is attributed to the horizontal ceiling over the 25-meter line; it may also be due in part to the use of a different weapon system. It is acoustically reflective, relatively low, and parallel to the floor, which appear to promote acoustical reflections between the ceiling and floor.

6. RECOMMENDATIONS:

a. USAFSAM/OEC recommends assigning a Risk Assessment Code (RAC) to the CATM firing range, IAW AFI 91-202, *The United States Air Force Mishap Prevention Program*, Attachment 7. The RAC number should be locally derived based upon the observed frequency and duration of firing operations, while taking into account the average sound pressure level of 134 dB(A), described in paragraph 2.c.

b. Until effective engineering controls can be implemented, close scrutiny to audiograms, as defined in Attachment 1 of AFOSH Standard 48-20, should be considered for CATM instructors. They cannot be adequately protected in the current range configuration with personal protective equipment and administrative controls.

c. Install sound-absorbing material to reduce the reverberant field. The reverberant field in the range should be minimized to reduce the noise level to protect students and instructors from hazardous noise exposure and to improve speech intelligibility.

d. The ceiling, overhead baffles, and side walls of the firing range should all be treated with acoustical absorption materials. Quilted fiberglass, or other fiberglass panels covered in a manner allowing easy cleaning, may be an option. There are also more fixed materials available, such as products offered by Pyrok or Troy Acoustics. Because shooters fire from three separate lines located 7, 15, and 25 meters from the target line, the treatment is needed essentially the length of the range. Since some Security Forces training also requires firing from down-range positions, down-range treatment is probably best. However, if the targets were moved rather than the firing line, down-range acoustical treatment would become less critical. Contact us for assistance in selecting specific treatment materials and for help with any questions related to the installation.

e. The corrugated sheet metal wall in the plenum should be treated in much the same manner as the other range walls. Another option for this area would be to cover with an acoustically absorptive sheet metal duct liner material.

f. The speaker system volume should be adjusted for weapon discharge or instructor lecturing. Additionally, CATM instructors should provide just-in-time training to students on proper use of hearing protection devices as part of classroom instruction. NIOSH has a short video on proper insertion of foam ear plugs available for download at http://www.cdc.gov/niosh/mining/products/movies/rphhi.wmv.

g. Perform a follow-up assessment once installation of acoustical treatment to the range is complete. The assessment should determine overall effectiveness, as well as categorize the type of noise as either impulse noise or continuous noise.

7. If there are any questions concerning the assessment, and for ongoing support, please contact Mr. Andrew Wells at DSN 798-3306 or via email at andrew.wells@wpafb.af.mil.

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